

Lawrence Livermore National Laboratory Site Specific Standard for Nonnuclear Safety Analysis

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LAWRENCE LIVERMORE NATIONAL LABORATORY SITE SPECIFIC STANDARD FOR NONNUCLEAR SAFETY ANALYSIS

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Abstract

Lawrence Livermore National Laboratory (LLNL) and the NNSA Livermore Site Office teamed up to prepare a site specific work smart standard setting requirements for preparation of safety basis documents for LLNL nonnuclear operations and facilities. This standard documents how all hazards (biological, chemical, explosive, industrial, and radiological) shall be evaluated, classified, analyzed, and controls developed. This standard was developed to evaluate hazards at the facility level to mesh with LLNL's ISM system for reviewing hazards at the activity level.

This standard presents an approach to establishing safety basis for nonnuclear operations and activities, taking a graded approach based on the potential for impacts to the health of collocated workers and the public. Direct worker safety is covered by LLNL's work activity level reviews and requirements. This standard includes streamlined mechanisms for classifying hazards based upon the unmitigated potential for human health impacts.

A review of practices at several private industries, government laboratories, and DOE complex sites provided a benchmark and comparison of safety analysis processes. These approaches were compared with LLNL's existing systems, leading to a determination that facility specific safety basis documents added value to a rapid authorization for new work activities in LLNL facilities. A process for hazard classification that would be viewed as more credible than the previous facility classification system was developed, including a method allowing correlation of chemical inventories with TEEL* concentrations. A graded approach for classification of explosive hazards, consistent with the DOE Explosive Safety Manual, was included. The standard was designed to be complementary with LLNL's existing work smart standards covering the hazards identified in a facility.

A standard for LLNL's Work Smart Standard set was prepared that will assure all hazards are covered with appropriate levels of analysis to provide a safety basis for nonnuclear facilities and operations.

Other sites may find the overall approach a credible mechanism with a graded approach to classification and hazard and accident analysis to provide a safety basis for nonnuclear facilities and operations.

This work was performed under the auspices of the U.S. Department of Energy by University of California Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

* Temporary Emergency Exposure Limits as per Doug Craig and shown on DOE's Chemical Safety Program website.

INTRODUCTION

Lawrence Livermore National Laboratory (LLNL) and our National Nuclear Security Administration Livermore Site Office (NNSA/LSO) jointly agreed that the work smart standard covering safety analysis for hazards not covered by 10CFR830, Subpart B was deficient. A standard identification team (SIT), made up of members from both LLNL and NNSA/LSO, developed a site specific standard setting requirements for preparation of safety basis documents for LLNL nonnuclear operations and facilities.

A goal of the effort was to build upon the existing work smart standards and only state “what” requirements that were seen to fill gaps in the existing standard set. To this end we determined that the existing work smart standards effectively cover worker hazards, hazard analysis, and control development. LLNL uses an Integration Work Sheet process to document work scope, hazard analysis and controls for worker level hazards and hazards to those in close proximity to the worker. While 29 CFR 1910.119, OSHA Process Safety Management, DOE Order 151.1a, Emergency Preparedness, and the DOE Manual 441.1, DOE Explosive Safety Manual, define some requirements for analysis for impacts to collocated workers and the public, we determined that these were not sufficient and that without a current DOE Directive this new work smart standard would fill the gap of requirements regarding analysis and controls to protect workers outside a facility and the public in non-nuclear facilities.

A benchmarking effort examined how similar research establishments assure that work in facilities receives adequate analysis for impacts to collocated workers and the public. Dialogs were held with six facilities, two other DOE-contractor facilities, two other federal government facilities, and two private industry facilities. We found, typically, individual buildings at a research facility had a relatively well-defined set of accepted operations and work outside this set of operations was either not accepted within the facility or was subject to extensive analysis at the inception of each new project or activity, which included examination of impacts to collocated workers and the public. Alternatively, at some sites each new operation’s ES&H analysis included examination of impacts to collocated workers and the public.

It was determined that neither of these approaches met the LLNL mission requirements and would, if adopted, likely slow our ability to begin new work. Therefore, LLNL adapted the approach of defining the work planned for each facility by assuring that a facility specific safety basis envelope was defined using a graded approach to the level of analysis required for examination of impacts to collocated workers and the public.

The following sections describe the resultant standard (LLNL UCRL-ID-150214, Rev. 1) and our plans for implementation. This standard was incorporated into our Contract as a Work Smart Standard in March 2003. It is important to note that LLNL work smart standards are requirement documents and, to the extent possible, are not intended to describe how the requirements are to be met. The decisions on the operational implementation are being made at this time. This paper will describe a few of these implementation decisions.

APPLICABILITY OF THE STANDARD

This standard applies to all facilities operated by LLNL for DOE and the National Nuclear Security Administration (NNSA), including:

- Facilities not located at the Livermore main site or Site 300, but operated by LLNL.
- On-site transportation activities that do not meet Department of Transportation (DOT) requirements.
- Category 2 or 3 facilities or operations with nonnuclear hazards, when the nonnuclear hazard is neither the initiator nor exacerbator of the consequences of a nuclear incident.
- Any other facility or operation not specifically excluded below.

This standard does not apply to:

- Facilities located at the Nevada Test Site.
- Transportation operations meeting DOT requirements.
- Facilities located at the Livermore main site or Site 300, but not operated by LLNL (e.g., construction office trailers).

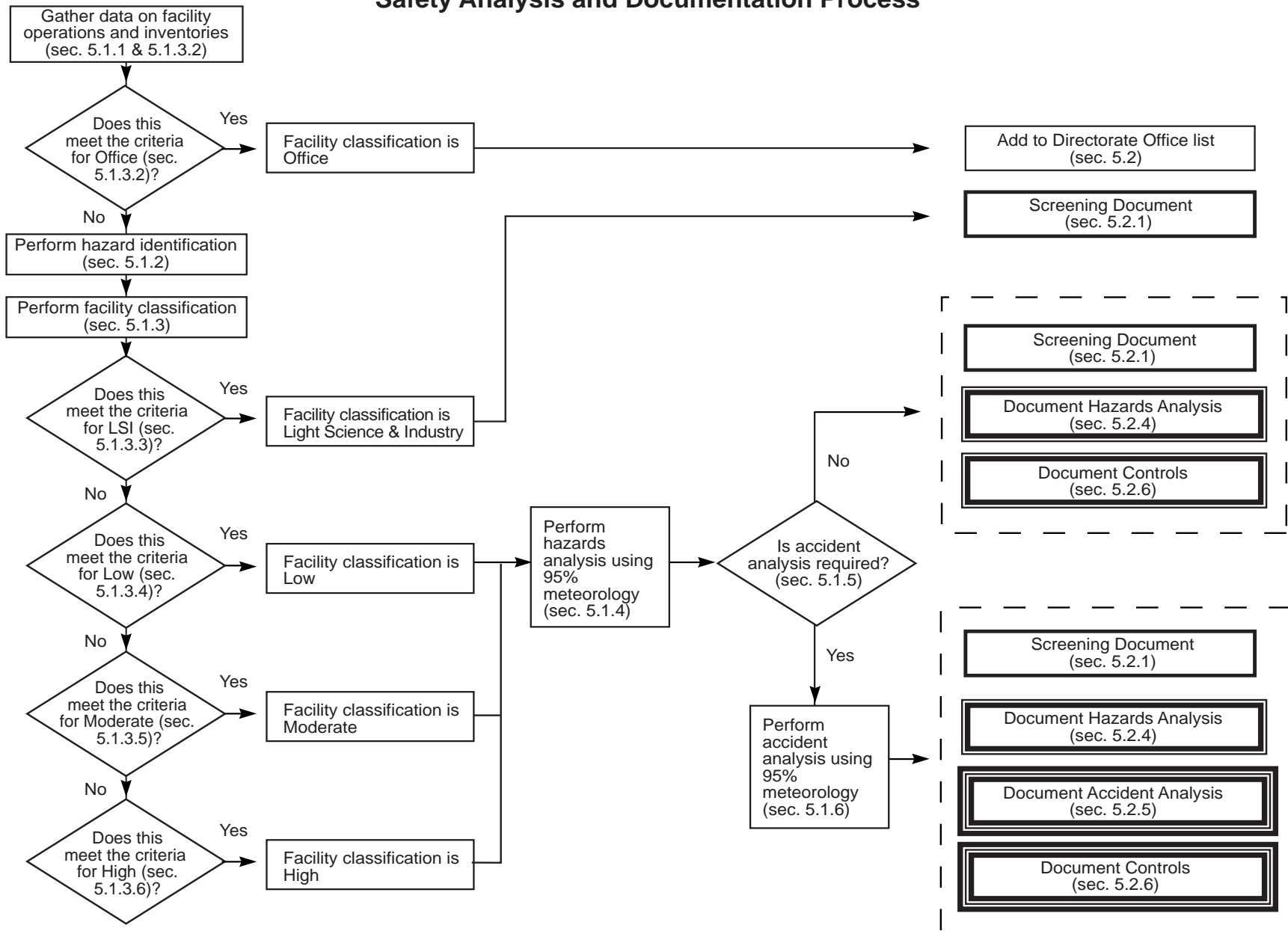
A controversial aspect of this standard was the inclusion of nonnuclear hazards in Category 2 or 3 facilities. The rationale here was that DOE Order 3009 does not clearly define how controls for such hazards are to be defined and this was a gap to be filled by this standard.

SAFETY ANALYSIS PROCESS

Safety Analysis shall be performed for all LLNL facilities. LLNL facilities that meet the classification criteria of being an Office only need to perform element A (see below) and to document its status as an office on the official listing; no further safety analysis is required. The content of the safety analysis for all other facilities shall be commensurate with the hazards (see Figure 1), but shall include at least elements A-C of the following:

- A. Identification of operations and inventories.
- B. Identification of hazards.
- C. Facility classification.
- D. Hazard analysis.
- E. Accident analysis.
- F. Control selection.

Safety Analysis and Documentation Process



NIF-1102-05580

Figure 1. Flowchart of the safety analysis and documentation process

HAZARD IDENTIFICATION

Each facility, other than an office, shall be reviewed to identify the presence of the following hazards:

- Chemicals.
- Explosives.
- Biohazardous materials.
- Radioactive materials and radiation-generating devices.
- Industrial hazards.

Specific lists of the hazards of each authorized type shall be the basis for the safety analysis. A graded approach may be used in determining the level of specificity for hazard identification. At a minimum, information adequate for proper facility classification shall be documented. The hazards of expected operations using the maximum planned quantities should be considered and listed. Hazards listed shall represent the facility safety envelope for work that may be authorized. Hazards not identified shall not be authorized without a change of the safety basis. Details regarding the location, storage, proximity to other materials and operations, frequency of use, and manner of use may be needed to perform hazard and accident analysis. Such details may not be necessary for all hazards.

LLNL shall establish a process for classification of all LLNL facilities covered by this standard. Facility classification is based on the potential for adverse health impacts to collocated workers and the public. Criteria shall be established for the following facility classifications:

- Office
- Light Science and Industry
- Low
- Moderate
- High

Criteria may include specific inventory thresholds for hazardous materials.

Office facilities are classified based on set criteria that determine the type of work that can be performed in the facility. Office facilities are workplaces for managerial, administrative, professional, and technical staff. The primary work that takes place in an office facility is the preparation, reading, communication, and storage of documents and data and the interaction between personnel through meetings, telephone conversations, and e-mail. Extensive use of office-related equipment is expected in office facilities. Office facilities will be listed by Directorate but no other safety basis documentation is needed.

Facilities other than office facilities shall be classified according to the potential of their operations to impact nearly all collocated workers and the public as follows:

0. No appreciable risk of health effects.
1. No more than mild, transient adverse health effects or the perception of a clearly defined objectionable odor or sensation.
2. No irreversible or other serious health effects or symptoms that could impair a person's abilities to take protective action.
3. No development of life-threatening health effects.

Facility classification shall be based on the highest level of hazard determined for any of the five hazard types (biological, chemical, explosive, industrial, radiological). The relationship between the potential impact to collocated workers, or the public, and facility classification is shown in the next table.

Facility classification	Collocated worker impact	Public impact
Light Science & Industry	1	0
Low	2	1
Moderate	3	2
High	<u>≥3</u>	<u>≥2</u>

See Appendix A for facility classification details.

This standard sets the “Light Science and Industry” facility classification at a level of hazard where it was determined that the requirements in LLNL’s on-line ES&H Manual (which incorporate LLNL Work Smart Standards) were sufficient. For this reason, no additional analysis or controls are needed after an Integration Work Sheet has been fully approved.

HAZARD ANALYSIS

Hazard Analysis shall be performed for all hazards classified as Low, Moderate, or High. The hazard level for each type of hazard (i.e., industrial, chemical, biological, radiological, and explosive) shall be determined, and the hazard analysis performed should be commensurate with the hazard level. Hazard analysis is primarily focused on understanding the behavior of the hazard in generic accident scenarios (spills, fire, etc...) Hazard Analyses should consider the following items:

- The way(s) in which the known hazards could manifest into undesirable consequences.
- The frequency of hazardous events based on operating history, analyst judgment, and industry data (note that this estimate is not specific to the facility, controls, or management for the specific hazard being analyzed but based on broad information about the frequency for similar operations and facilities through their life cycle).
- The unmitigated consequences of an event (the consequences of a release of dispersible material shall be estimated for 95th% atmospheric conditions).
- The assumptions regarding parameters to the analysis that must be controlled.
- The available preventative and mitigative controls applicable to the known hazards.

Hazard Analysis shall be used to determine what hazards and hazardous events require accident analysis. This determination shall be made by using estimated frequencies and unmitigated consequences, in conjunction with the matrix in Figure 2.

Hazard Analysis is an iterative process. Suggestions for improving safety that arise from the preliminary iterations should be factored into subsequent iterations. If Accident Analysis is required, less iteration on the Hazard Analysis should be necessary. The following actions are necessary to meet requirements in other parts of this standard with respect to Hazard Analysis if Accident Analysis is not required:

- Checking the Residual Risk Matrix (Figure 3) to determine the risk acceptance authority.
- Identifying if any controls in addition to those required by the ES&H Manual will be imposed.

DETERMINATION OF NEED FOR ACCIDENT ANALYSIS

Hazard analysis information shall be binned per the Analysis Level Matrix in Figure 2. The results of the binning shall determine whether Accident Analysis shall be performed.

Estimated 95th % Consequences of an Unmitigated Release	Higher consequences			
	Irreversible health effects onsite, Recoverable health effects offsite.			
	Recoverable health effects onsite, Mild sensation or odor offsite			
		The event is not expected to occur but may occur during the facility or operation lifetime	The event could be expected to occur once during the facility or operation lifetime	Event is likely to occur several times during the facility or operation lifetime
		Estimated Event Probability		

Key	
	Hazard Analysis required
	Hazard Analysis and Accident Analysis required

Figure 2. Analysis Level Matrix.

ACCIDENT ANALYSIS

Accident Analysis differs from Hazard Analysis primarily by evaluating specific accident scenarios that are associated with hazards and studying the component parts of a scenario in further detail to understand how each of these parts contributes to the overall risk of the accident scenario. Accident Analyses should:

- State what specific accidents can occur.
- Identify hazardous event initiators present in the facility and processes.
- State potential scenarios in narrative or illustrative form.
- Identify what specific events within a scenario contribute to the frequency of the accident.
- Determine the likelihood of the overall scenario.
- Determine the mitigated consequences of an event.
- Determine those elements that are the major contributors to the risk from this hazard.
- State preventive and mitigative controls.
- Evaluate options and effectiveness of the controls.
- Identify credited controls.
- Identify uncertainties and sensitivities in the analysis.

Like Hazard Analysis, Accident Analysis is an iterative process. The final results of Accident Analyses shall be checked against the Residual Risk Matrix, Figure 3, to provide input to the selection of controls and to determine the risk acceptance authority level.

Accident analysis shall address the probability of release, event consequences, accident sequence, and selection of controls. Analysis may be qualitative in assessing the consequences to on-site personnel but should be quantitative for off-site individuals.

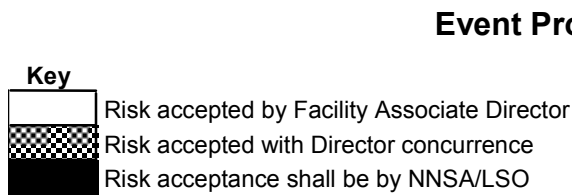
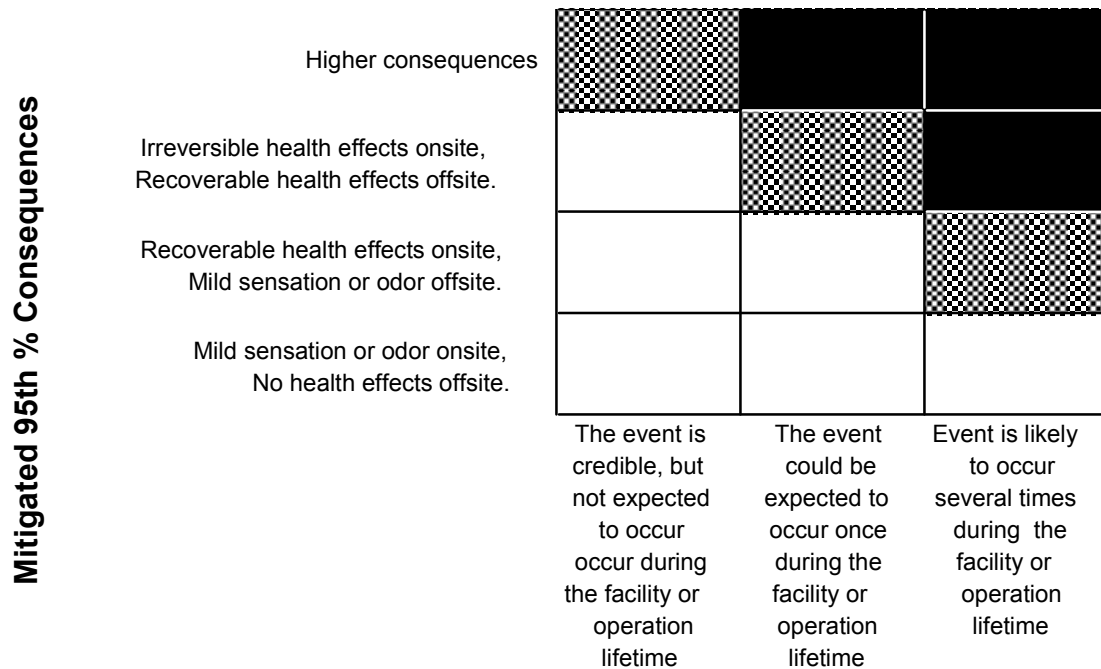


Figure 3. Residual Risk Matrix.

CONTROLS

Controls are used to reduce the likelihood of accidents or mitigate their consequences. The process for control selection is described in this section. All facilities shall develop and implement controls necessary to meet requirements in the LLNL Work Smart Standards set, including those established by the Institutional Biosafety Committee (IBC) during the determination of Biosafety Levels.

The unmitigated impacts of releasing the hazard of concern, i.e., a parking lot scenario, shall be considered to initiate the control selection process. Preventive and/or mitigative controls shall be applied to the scenario to reduce the residual risk, see Figure 3.

CONTROLS IDENTIFIED THROUGH HAZARD ANALYSIS

When performing Hazard Analysis, controls may have been identified in addition to those required by LLNL's Work Smart Standards and ES&H Manual. The facility management should identify which of these controls provide additional protection to collocated workers and the public or assure operability of other controls. If the facility management commits to

implementation of these controls, they shall be listed in the control section of the safety basis document (see Figure 1).

SELECTION OF CREDITED CONTROLS

Controls identified through Accident Analysis, as required by this standard, shall be evaluated to determine credited controls. A control or collection of controls required to reduce the residual risk acceptance level (see Figure 3) shall be credited controls.

Many types of controls mechanisms are available; however, the selection of controls should be based on the following hierarchy whenever possible.

- Passive over Active
- Preventive over Mitigative
- Engineered over Administrative

Controls should be selected to change the unmitigated risk to a residual risk that can be accepted by the Facility Associated Director. A control(s) identified through Accident Analysis that is necessary to reduce the risk (either the probability or consequence or both) to collocated workers or the public to accepted levels is called a Credited Control. There may be a number of combinations of controls necessary to reduce the residual risk. Typically, the minimal set is chosen as the set of credited controls. If several scenarios require accident analysis, different credited controls may be derived from each. Alternatively, a common control may be effective at reducing the risk of more than one scenario. The necessary degree of risk reduction is determined from the Residual Risk Matrix shown in Figure 3. In rare cases controls for certain mission essential operations may not be sufficient to reach a residual risk that can be accepted by the Facility Associate Director. Only in these rare cases and only with the LLNL Director's approval (or in the most extreme cases by NNSA/LSO) can operation be approved with higher residual risk. Justification for such approval is essential.

OPERATIONAL SAFETY REQUIREMENTS

Credited controls shall be documented, described, and maintained through Operational Safety Requirements (OSRs). OSRs may include safety limits, operating limits, surveillance requirements, administrative and management controls, use and application provisions, and design features. OSRs shall be established for High facilities for credited controls. OSRs may be required for Moderate and Low facilities if credited controls are identified. In addition, a control that is relied upon to maintain the facility's classification may be an OSR for Low, Moderate, or High facilities. If reporting of information from OSRs is necessary to ascertain operational status of the facility, a section of the safety basis document should specify the information to be reported, the frequency of reporting, and who is to receive the information. If reporting is not expected on a given frequency, the driver for reporting should be clarified.

ADDITIONAL REQUIREMENTS

Once the process described above is completed documentation is prepared that is commensurate with the level of risk. For example, for Light Science and Industry facilities since no hazard or accident analysis is required information regarding the facility hazard identification will make up the majority of what is called the screening report. Hazard Analysis and Accident Analysis sections are added as needed. Control documentation is the final section of the overall safety basis document.

Once the safety basis document is finalized it is submitted for risk acceptance and approval. The standard specifies that NNSA/LSO has risk acceptance authority for all facilities. However, this authority may be delegated to LLNL. The standard did not specify any risk acceptance delegation. However, historical practice has been for LLNL to have risk acceptance for lower risk operations that take place in the majority of facilities. The approval of the safety basis is the method for risk acceptance for those facilities. The safety basis is approved at the level specified by residual risk matrix shown in Figure 3.

A formal change control process is required by the standard. Again, a graded approach will be used. The formal change control process shall be initiated by:

- A proposed change in inventory or operations that would exceed that currently analyzed or bounded by the safety basis envelope.
- Previous analyses discovered to be inadequate (e.g., a potential hazard was discovered but not identified or was incorrectly analyzed in the SBE document).
- Modification to facility, equipment, or controls that alters the safety basis or initial assumptions of the safety basis.

The standard also specifies that nearby facility managers are informed of hazards that could impact their workers or facilities. When the mitigated consequence of an event has the potential for impact such that nearly all workers in a nearby facility could experience or develop irreversible or other serious health effects or symptoms that could impair their abilities to take protective action, this potential impact shall be communicated to the management of the nearby facility. If Accident Analysis shows that the mitigated consequence of events could result in physical phenomena that could render equipment inoperative in a nearby facility, this possible consequence shall be communicated to the facility management of the nearby facility. The management of the nearby facility shall then be able to consider such external events in their safety analysis or emergency planning.

Additionally, sections describing the requirements for preliminary safety basis documentation, quality assurance, training, and the reporting of noncompliances or inadequacies are covered in the standard.

IMPLEMENTATION

The LLNL ES&H Manual is the internal document that specifies how the requirements in LLNL's Work Smart Standards are to be implemented. This document specifies roles and responsibilities and states how specific requirements are to be met. The ES&H Manual document for implementation of this new standard is being written at this time. In addition, a pilot program is being held to determine exactly how each of the requirements in the standard will be implemented.

We determined that we could implement the reduced requirements for "Office" facilities without the full ES&H Manual documentation. We issued a special change to the ES&H Manual allowing this part of the standard to be implemented in March 2003.

During the pilot process we determined that the definition of a facility needed to be refined. There are some facilities that have multiple segments but are labeled as one facility. There are

some facilities that are one building but are operated administratively as separate facilities. Such nuances are being worked by the same team that developed the original standard to assure we meet the intent of the standard.

We also determined there was inconsistency in the identification of hazards, especially standard industrial hazards. We also found that those preparing lists of hazards would list initiators for releases of chemicals or energy as hazards. The ES&H Manual will have a list of standard industrial hazards to aid in hazard identification.

A number of hazards that might require hazard analysis and possibly accident analysis are common to a number of facilities at LLNL, such as exterior large cryogen tanks, diesel fuel tanks for generators, and portable propane tanks for maintenance and repairs. LLNL's Authorization Basis Section will develop common hazard analyses and accident analyses, when necessary to aid in consistency across the site.

SUMMARY

A site-specific work smart standard was developed to assure that potential impacts to collocated workers and the public are well understood, analyzed and controlled. The process was developed in a manner that builds upon LLNL's existing work smart standard set, without duplication of requirements, and allows for identification of potential hazards and rapid approval for new projects.

The standard provides a rigor to the system while having credibility with LLNL workers. The implementation process for the standard is currently underway.

APPENDIX A

FACILITY CLASSIFICATIONS

LIGHT SCIENCE AND INDUSTRY

Facilities classified as Light Science and Industry have the potential for unmitigated release of hazards with impacts to collocated workers that are believed to cause no more than mild, transient adverse health effects or the perception of an objectionable odor or sensation for nearly all individuals and with impacts to the public that are believed to present no appreciable risk of health effects) for nearly all individuals. The following are typical examples or thresholds for each hazard type:

- Industrial—Plumbing, carpentry, and machine shops using steel, aluminum, copper, plastic, wood, or other common materials; electronics shops; laser laboratories; and experimental equipment design and testing laboratories.
- Chemical—Small-scale chemical laboratories, dye laser laboratories, small-quantity chemical storage, and facility chemical inventories less than the low classification threshold as defined by the LLNL chemical quantity tables for classification.
- Biological—Biosafety Level (BSL) 1 and 2 operations.
- Radiological—Radiation-generating devices not covered by DOE O 420.2A, radioactive material inventories less than the reportable quantities listed in 40 CFR 302.4, Appendix B.
- Explosive—Commonly available powder-actuated tools, total room inventories involving secondary explosives with a mass of 10 mg or less or primary explosives with a mass of 1 mg or less, and storage (in greater than operational-use quantities) of ammunition classified as 1.4 S in accordance with Section 5.4.3.4 of DOE-STD-1091-96. Ammunition that is not classified as 1.4 S is not permitted.

LOW

Facilities classified as Low have the potential for unmitigated release of hazards with impacts to collocated workers that are believed to include no irreversible or other serious health effects or symptoms that could impair their abilities to take protective action) for nearly all individuals and whose impacts to the public are believed to be no more than mild, transient adverse health effects or the perception of an objectionable odor or sensation for nearly all individuals. The following are typical examples or thresholds for each hazard type:

- Industrial— If a facility has an industrial hazard that could meet the above conditions.
- Chemical—Facility inventory levels kept within the Low range as defined in the LLNL chemical quantity tables for classification.
- Biological—BSL 3 operations.
- Radiological—Radioactive material inventories greater than the reportable quantities listed in 40 CFR 302.4, Appendix B, but less than the Category 3 threshold of DOE-STD-1027-92 and qualified sealed sources exceeding the Category 3 threshold but exempted from inventory under DOE-STD-1027-92. If through analysis under

10CFR830, Subpart B, the facility is determined to be below Category 3, it shall be classified as Low.

- Explosive—The maximum credible event used to meet the Level of Protection and Quantity-Distance requirements of the DOE Explosives Safety Manual does not exceed 10 grams for United Nations Organization (UNO) Hazard Class 1.1, 1.2, 1.4 (except as stated for 1.4S for LSI facilities above) 1.5 or 1.6 explosives or 200 grams for UNO Hazard Class 1.3 explosives.

MODERATE

Facilities classified as Moderate have the potential for unmitigated release of hazards with impacts to collocated workers that are believed to include no life-threatening health effects for nearly all individuals and whose impacts to the public are believed to include no irreversible or other serious health effects or symptoms that could impair their abilities to take protective action for nearly all individuals. The following are typical examples or thresholds for each hazard type:

- Industrial— If a facility has an industrial hazard that could meet the above conditions.
- Chemical—Facility inventory levels kept within the Moderate range as defined in the LLNL chemical quantity tables.
- Biological—Not Applicable.
- Radiological—Radioactive material inventories that exceed the threshold of DOE-STD-1027-92 shall be managed as a nuclear facility in accordance with 10 CFR 830, Subpart B, instead of this standard for nonnuclear facilities.
- Explosive—All activities or materials that are not allowed in light science and industry or Low facilities but that meet the quantity–distance requirements specified in DOE Manual 440.1-1 and transportation of explosive material on site that does not meet DOT requirements.

HIGH

Facilities classified as High have the potential for unmitigated release of hazards with impacts to collocated workers that are believed to include life-threatening health effects and whose impacts to the public are believed to include irreversible or other serious health effects, symptoms that could impair their abilities to take protective action, or possible life-threatening health effects. The following are typical examples or thresholds for each hazard type:

- Industrial— If a facility has an industrial hazard that could meet the above conditions.
- Chemical—Facility inventory levels exceeding the Moderate range as defined in the LLNL chemical quantity tables.
- Biological—BSL 4 operations.
- Radiological—Radioactive materials inventories that exceed the Category 3 threshold of DOE-STD-1027-92 shall be managed as a nuclear facility in accordance with 10 CFR 830, Subpart B, instead of this standard for nonnuclear facilities.
- Explosive—Any activities or materials necessitating an exemption from the quantity–distance requirements specified in DOE Manual 440.1-1.